Predictive Factors for Radiological Outcomes following Surgical Treatment of Acetabulum Fractures

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Objective: *The purpose of this study was to evaluate the effects of various factors on radiological outcomes following surgical treatment of displaced acetabular fractures.*
Materials and Methods: *Radiological outcomes of 81 acetabular fractures which had been surgically treated from October 2014 to September 2017 were evaluated. Factors in the analysis included age, gender, mechanism of injury, smoking, pattern of fractures, time before surgery, initial displacement, and quality of reduction. Multivariate logistic regression analysis was performed to calculate predictive factors.*
Results: *Of the 81 acetabular fractures, 57 (70.37%) were males and 24 (29.63%) were females. The mean age was 38.67 years (range 15-68). The mechanism of injury in 65 (80.25%) of the cases was a traffic vehicle accident and in 16 (19.75%) it was a fall from height. Of the patients, 25 (31.86%) smoked. Fracture types included simple fractures 30 (30.07%) and associated fractures 51 (62.96%). The mean time to surgery was 15.07 days (range 1-59). There was an associated hip dislocation in 27 cases (33.33%), initial fracture displacement ≤ 20 mm in 61 cases (75.31%) and displacement > 20 mm in 20 cases (24.69%). Of the fracture reductions, 20 (20.49%) were anatomical reductions, 26 (32.20%) were categorized as good reductions and 35 (43.21%) were rated as poor reductions. Radiological outcomes were good in 35 cases (43.21%), fair in 23 cases (28.40%) and poor in 23 cases (28.40%). None of the cases had an excellent outcome. Age, gender, mechanism of injury, and time to surgery were not correlated with radiological outcomes. Variables that were statistically significantly associated with outcomes were quality of reduction (p=0.000), initial displacement (p=0.007), fracture pattern (p=0.021) and associated hip dislocation (p=0.030).*
Conclusions: *Poor reduction, initial displacement ≥ 20 mm, associated hip dislocation, and fracture pattern are correlated with a poor outcome prognosis for surgically treated acetabular fractures.*

Keywords: *Acetabulum fractures, Surgical treatment, Outcome, Predictive factors*

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Introduction

An acetabular fracture is a complex fracture which is difficult to treat surgically. The incidence of acetabular fractures is approximately 3 patients/100,000 population/year[1]. The most common mechanisms of injury are motor vehicle accidents and falls from height[1]. Studies by Letournel and Judet and by Matta reported the best results from surgical reduction for anatomical reduction of the articular surface[2-5]. Meta-analysis by Giannoudis PV et al. stated that many factors can affect the outcome following surgical treatment[7]. Many studies have suggested prognostic factors[7-9,12-15] including age, gender, fracture pattern, delayed surgery, initial displacement, quality of reduction, associated injuries, and femoral head impaction. The objective of acetabular fracture treatment is to restore normal function of the hip. The purpose of this study was to evaluate the effect of selected factors on radiological outcomes following surgical treatment of displaced acetabular fractures.

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Materials and Methods

Institutional review board approval was obtained before the present study was started. This retrospective study included patients who had undergone surgical treatment of acetabular fractures and who had had a complete 6 months follow up at Khon Kaen Hospital from October 2014 to September 2017. There were a total of175 acetabular fractures of which 123 cases received surgical treatment. In the surgical treatment group, 81 cases had complete data records while in 42 cases there was some loss of demographic data, operative records, and/or preoperative or postoperative X-rays. The radiological outcomes of the 81 cases with full records were reviewed by two evaluators; if they failed to reach a conclusion, a third evaluator made a final decision. The Matta scoring system[2] for radiological outcome assessment defines “excellent” to mean a normal-appearing hip joint, “good” as mild changes with

minimal sclerosis and joint narrowing (<1 mm), "fair" as intermediate changes with moderate sclerosis and joint narrowing (<50%), and "poor" as advanced changes in joint narrowing (> 50%) and collapse or wear of the femoral head. We divided radiological outcomes into 2 groups: "acceptable," which combines Excellent and Good, and "Unacceptable" for Fair and Poor. The affect of gender, age (≤55 years and >55 years), smoking, mechanism of injury, time to surgery (≤ 14 days and >14 days), initial displacement (≤ 20 mm and >20mm), associated hip dislocation (including posterior and central hip dislocation), quality of reduction (using the Matta quality of reduction grading system) and the pattern of the fracture were evaluated. Fracture patterns were determined using the Judet and Letournel classification system[3,4] and were divided into a simple fracture group (anterior wall, posterior wall, anterior column, posterior column, transverse) and an associated fracture group (posterior column + posterior wall, transverse + posterior wall, T-shape, anterior + posterior hemi-transverse, both columns) to evaluate the relationship between fracture patterns and outcomes. The Matta quality of reduction system was used to divide outcomes into an acceptable reductions group (anatomical and good reductions (1-3 mm) and an unacceptable reductions group (poor reduction (> 3 mm). Multivariate logistic regression analysis was performed to predict the risk factor.

Table 1 Baseline characteristics

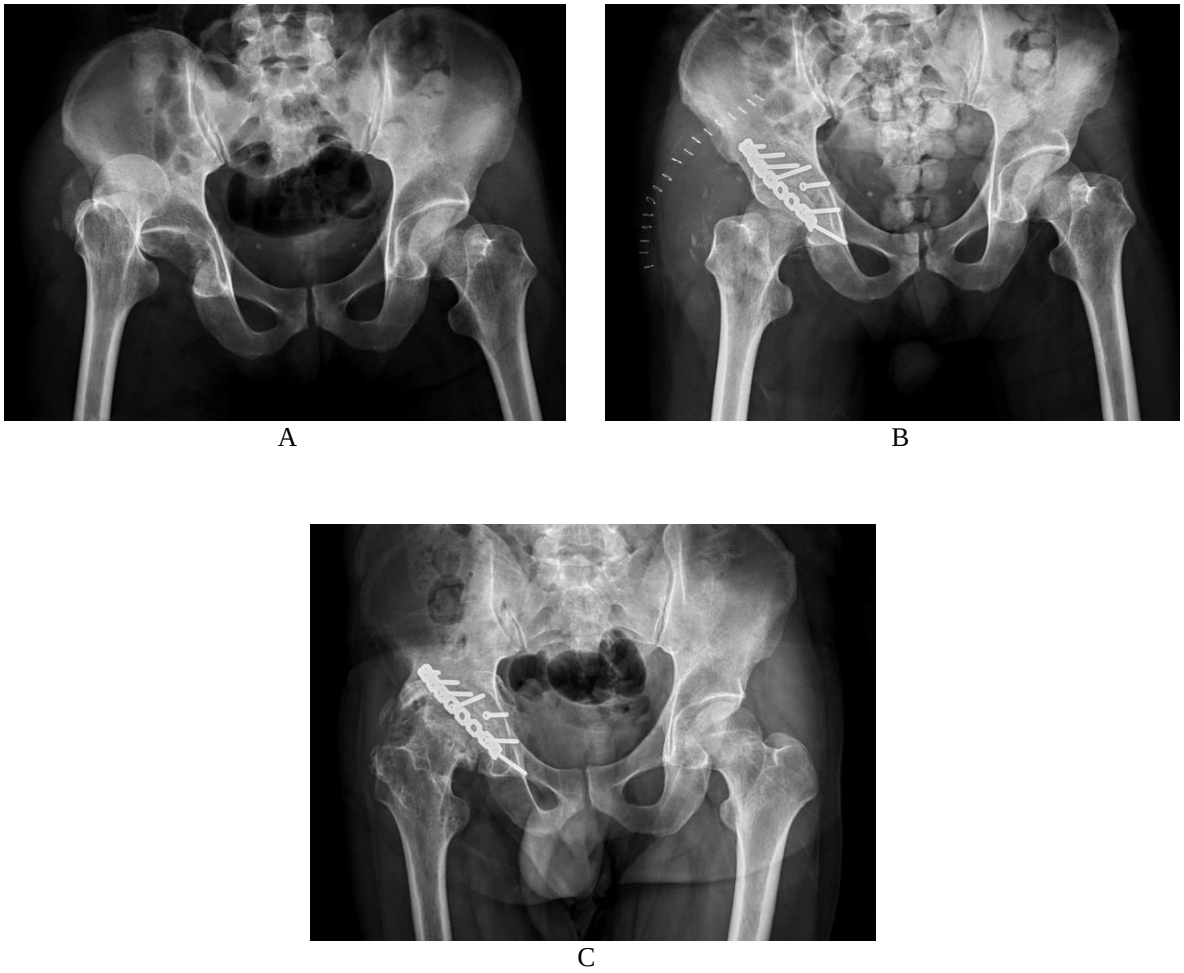
Characteristic	n (%)
Mean age in years (range)	38.67 (15-68)
Age Group	
≤ 55 years	69 (85.19)
> 55 years	12 (14.81)
Gender	
Male	57 (70.37)
Female	24 (29.63)
Mechanism of injury	
Traffic accident	65 (80.25)
Fall from height	16 (19.75)
Smoking	
Yes	56 (69.14)
No	25 (30.86)
Fracture pattern	
Simple fractures	30 (37.04)
Posterior wall	14 (17.28)
Posterior column	0 (0)
Anterior Wall	0 (0)
Anterior column	3 (3.70)
Transverse	13 (16.05)
Associated fractures	
Posterior column+ Post Wall	51 (62.96)
Transvers + Post wall	3 (3.07)
T-Shape	8 (9.88)
Anterior + Posterior	1 (1.23)
hemi-transverse	13 (16.05)
Both Column	26 (32.10)
Mean time to surgery – days (range)	15.07 (1-59)
≤ 14 days	44 (54.32)
> 14 days	37 (45.68)
Associated hip dislocation	
Present	27 (33.33)
Absent	54 (66.67)
Initial displacement	
≤ 20 mm	61 (75.31)
> 20 mm	20 (24.69)
Quality of reduction	
anatomical (0-1 mm)	20 (26.49)
Good (2-3 mm)	26 (32.20)
Poor (>3 mm)	35 (43.21)
Radiological outcome	
Excellent	0 (0)
Good	35 (43.21)
Fair	23 (28.40)
Poor	23 (28.40)

Results

Of the 81 acetabular fractures, 57 (70.37%) were males and 24 (29.63%) were females. The mean age was 38.67 years (range 15-68). The mechanisms of injury were traffic vehicle accidents 65 (80.25%) and falls from height 16 (19.75%). Of all the patients, 25 (31.86%) were smokers. The fracture patterns were simple fractures 30 (37.04%) and associated fractures 51 (62.96%). The mean time to surgery was 15.07 days (range 1-59). Associated hip joint dislocation was present in 27 (33.33%) of the cases. The initial fracture displacement was ≤ 20 mm in 61 cases (75.31%) and > 20 mm in 20 cases (24.69%). Distribution of quality of fracture reduction was 20 anatomical reductions (20.49%), 26 good reductions (32.20%) and 35 poor reductions (43.21%). Radiological outcome (Matta radiological grading) at the 6 months follow-up was good in 35 cases (43.21), fair in 23 cases (28.40%) cases and poor in 23 cases (28.40%). There were no cases with an excellent outcome.

Factors that were not statistically significant include age group (p=0.907), gender (p=0.199), mechanism of injury (p=0.542), smoking (p=0.561) and time to surgery (p=0.649). Of the 51 cases identified with associated fractures, 34 (66.67%) were rated as having an unacceptable radiological outcome and of the 30 cases with simple fractures, 12 (40.00%) had an unacceptable outcome, a statistically significant difference (p=0.021). Of the 27 cases with associated hip dislocation, 20 (74.07%) had unacceptable outcomes. There were 54 cases without hip dislocation of which 26 (48.15%) had unacceptable

outcomes which was statistically significant (p=0.030). Of the 20 patients with an initial displacement > 20 mm, 17 (85.00%) had an unacceptable outcome while among the 61 cases with initial displacement ≤ 20 mm, only 17 (27.87%) had an unacceptable outcome (p=0.007). Quality of reduction in the 0-3 mm group had unacceptable outcomes in 16 of 46 cases (34.78%), while the > 3 mm group had unacceptable outcomes in 30 of 35 cases (85.71%), also statistically significant (p=0.000).



A B C

Fig.1 A 34 years old male. (**A)** Transverse fracture with posterior wall and posterior hip dislocation. (**B)** Post-operative film after open reduction and internal fixation. (**C)** Six month X-ray showing advance radiological change of hip joint and osteoarthritis. Radiological outcome classified as a Poor.

Table 2 Univariate analysis of predictive factors for acetabular fracture surgical treatment outcomes

		Radiological Outcome			**Crude Odds**	**p-value**
Age Group		**Excellent + Good**	**Fair + Poor**	**Total**		
	≤ 55 years	30	39	69	0.928	0.907
	> 55 years	5	7	12		
Gender						
	Male	22	35	57	1.88	0.199
	Female	13	11	24		
Mechanism of injury						
	Traffic accident	27	38	65	1.407	0.542
	Fall	8	8	16		

	Radiological Outcome			Crude Odds	p-value
Smoking	Excellent + Good	Fair + Poor	Total		
No	23	33	56	1.324	0.561
Yes	12	13	25		
Fractures Pattern					
Simple fractures	18	12	30	0.333	0.021*
Associated fractures	17	34	51		
Time to surgery					
≤ 14 days	18	26	44	1.227	0.649
> 14 days	17	20	37		
Associated hip dislocation					
Present	7	20	27	3.076	0.030*
Absent	28	26	54		
Initial displacement					
≤ 20 mm	32	29	61	6.252	0.007*
> 20 mm	3	17	20		
Quality of reduction					
0-3 mm	30	16	46	11.25	0.000*
> 3 mm	5	30	35		

*Statistically significant

Multivariate analysis of predictive factors for acetabular fracture surgical treatment outcomes adjusted for age, gender and mechanism of injury found that quality of reduction, fracture pattern, initial fracture displacement and associated hip dislocation were the main prognostic factors. Poor outcomes are predicted by remaining displacement > 3 mm after reduction of fractures, initial fracture displacement of > 20 mm and the presence of hip dislocation with acetabular fractures. Simple fracture patterns have a good prognosis for acceptable outcomes after surgical treatment.

Table 3 Multivariable analysis of predictive factors for acetabular fracture surgical treatment outcomes

	Adjusted for age, gender and mechanism of injury		
	Adjust ODDs	95% CI	p-value
Quality of reduction	18.805	4.689-75.462	0.000
Fracture pattern	0.803	0.671-0.962	0.017
Initial displacement	5.183	1.333-20.151	0.018
Associated hip dislocation	4.648	1.276-16.929	0.020

A

B

C

Fig.2 A 64 year old male fell from a height and fractured both acetabula. (**A)** Both acetabular fractures: anterior column fracture (right), T-shaped fracture (left). (**B)** Postoperative film after open reduction and anterior column plate fixation. **(C)** Radiological outcome at 6 months: mild change and minimal sclerosis on left hip and moderate change on right hip.

Discussion

Previous studies have shown that radiological and clinical outcomes following surgical treatment of acetabular fractures depend on many factors. In 1996 Matta JM et al.[2] reported on clinical outcomes after surgical treatment of acetabular fractures. Clinical results were 40% excellent outcomes, 36% good outcomes, 8% fair outcomes, and 16% poor outcomes. Clinical outcomes were found to be closely related to radiographic outcomes. Poor clinical results were correlated with associated injuries of the femoral head, older age, and operative complications. Results were positively affected by anatomical reduction and postoperative congruity between the femoral head and the acetabular roof. P. V. Giannoudis et al.[7] conducted a meta-analysis of operative treatment of displaced fractures of the acetabulum that included 160 manuscripts and 3,670 fractures. The mean age of the patients was 38.6 ± 4.6 years. The most frequent cause of injury was traffic accidents (80.5%). The most frequent type of fracture was posterior wall fractures (23.9%), both columns fractures (22%) and transverse fractures with posterior wall fractures (17.7%). The mean period before surgery was 8.9 ± 2.9 days. The incidence of late complications from osteoarthritis was 19.8%, of avascular necrosis of femoral head was 5.6% and of heterotopic ossification was 5.7%. Briffa N. et al.[8] reported that poor prognostic factors for outcomes of acetabular fracture fixation with based on ten years of follow-up included increased age, longer delay before surgery, lower quality of reduction and some specific fracture patterns. The study of patients with fractures of the acetabulum and concomitant posterior dislocation of the hip conducted by M. Bhandari et al.[9] found the quality of the reduction was the most important factor in predicting radiological and clinical outcomes. Meena UK et al.[6] stated that the quality of a poor quality reduction, the presence of associated injuries, an initial fracture displacement of > 20 mm (P = 0.018), joint dislocation and longer delay before surgery were prognostic factors related to poor radiological and clinical outcomes of surgical treatment of acetabular fractures. T.A. El-khadrawe et al.[16] stated that negative prognostic factors included pelvic ring injury, fracture of the posterior wall, articular surface comminution and the presence of intra-articular fragments.

The demographics of patients in the present study are similar to those in previous studies. The mean age in the present study was 38.67 years (range 15-68). The mechanisms of injuries were vehicle accidents (65 cases, 80.25%) and falls from height (16 cases, 19.75%). The most frequent pattern of fracture was both column fracture (32.10%). The quality of reduction, initial displacement, associated hip dislocation and fracture pattern were significant factors in predicting outcomes of acetabular fracture treatment, but delayed surgery, age, gender, smoking and mechanism of injury were not significant. A previous study found that delayed surgery (>14 days) was a significant factor for predicting the outcome of treatment, but our study found delay to be not significant. That is particularly interesting as the mean waiting time to surgery in this study was 15.07 days, while in the meta-analysis by P. V. Giannoudis et al.[7] the mean waiting time was only 8.9 ± 2.9 days.

One limitation of this study is that due to incomplete information we were able to include only 81 of 123 acetabular fracture patients who had received surgical treatment. In addition to retrospective conducting a retrospective rather than

a prospective review, there was a problem with available data was negatively impacted by poor compliance on the part of patients. The most common reason for poor compliance was patient socioeconomic problems. Additionally, radiological outcomes alone do not fully represent the quality of treatment. Long term evaluation of clinical outcomes is required as well to better predict patient quality of life.

Conclusions

Poor fracture reduction (> 3 mm.), initial displacement of more than 20 mm, the presence of associated hip dislocation and associated fractures (Judet and Letournel classification) suggest a poor prognosis for radiological outcomes after surgical treatment of acetabular fractures. Other variables, including age, gender, mechanism of injury, smoking and time to surgery do not affect radiological outcome.

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ปัจจัยพยากรณ์ผลการรักษาจากภาพถ่ายรังสี ภายหลังการผ่าตัดรักษากระดูกเบ้าข้อสะโพกหัก

อุดมศิลป์ สิงห์แจ่ม, พบ, ธนนิตย์ สังคมกำแหง, พบ

วัตถุประสงค์: เพื่อศึกษาปัจจัยที่มีผลต่อผลการรักษาทางภาพถ่ายรังสีของการรักษากระดูกเบ้าข้อสะโพกหักด้วยการผ่าตัด
วิธีการศึกษา: การศึกษาแบบย้อนหลังเก็บข้อมูลผลการรักษาจากภาพถ่ายรังสีของผู้ป่วยกระดูกเบ้าข้อสะโพกหักที่ได้รับการรักษาด้วยการผ่าตัดและติดตามการรักษาครบหกเดือนในโรงพยาบาลขอนแก่น จังหวัดขอนแก่น ประเทศไทย ตั้งแต่เดือนตุลาคม 2557 ถึง กันยายน 2560 ทำการเก็บรวบรวมข้อมูลที่คาดว่ามีผลต่อการรักษา ได้แก่ อายุ เพศ สาเหตุการบาดเจ็บ ประเภทของกระดูกหัก การสูบบุหรี่ ระยะเวลารอผ่าตัด การเคลื่อนของกระดูกก่อนผ่าตัด คุณภาพของการจัดเรียงกระดูก นำมาวิเคราะห์ทางสถิติด้วยวิธี multivariate logistic regression เพื่อหาปัจจัยที่มีผลต่อการรักษา
ผลการศึกษา: ข้อมูลทั้งหมด 81 คน พบว่าเป็น ชาย 57(70.37%) คน หญิง 24(29.63%) อายุเฉลี่ย 38.67(15-68) ปี สาเหตุจากอุบัติเหตุจราจร 65(80.25%) ตกที่สูง 16(19.75%) ผู้ป่วยสูบบุหรี่ 25(30.86) คน ชนิดของกระดูกหัก simple type 30(37.04%) associated type 51(62.96%) ระยะเวลารอผ่าตัด 15.07(1-59) วัน ข้อสะโพกหลุด 27(33.33%) คน การเคลื่อนของกระดูกหักก่อนผ่าตัด ≤ 20 มม 61(75.31%) คน และ > 20 mm 20 (24.69%) คน คุณภาพการจัดเรียงกระดูก anatomical reduction 20(20.49%) คน good reduction 26 (32.20%) คน และ poor 35 (43.21%) คน ผลการรักษาทางภาพถ่ายรังสี good outcome 35(43.21%) คน fair outcome 23(28.40%) คน poor outcome 23(28.40%) คน และไม่มี excellent outcome ปัจจัยที่ไม่พบว่ามีผลต่อผลการรักษา ได้แก่ อายุ เพศ สาเหตุการบาดเจ็บ ระยะเวลารอผ่าตัด ปัจจัยที่พบว่ามีผลต่อผลการักษาได้แก่ คุณภาพการจัดกระดูกเข้าที่ (p=0.000), การเคลื่อนของกระดูกก่อนผ่าตัด (p=0.007), ประเภทของกระดูกหัก (p=0.021) และการมีข้อสะโพกหลุดร่วมด้วย (p=0.030)
สรุปผลการักษา: ปัจจัยที่คาดว่าจะทำให้ผลการักษากระดูกเบ้าข้อสะโพกหักไม่ดี คือ การจัดเรียงกระดูกหักได้ไม่ดี การที่กระดูกหักเคลื่อนก่อนผ่าตัดมากกว่า 20 มิลลิเมตร การมีข้อสะโพกหลุดร่วมกับกระดูกเบ้าข้อสะโพกหัก และประเภทของกระดูกหักแบบซับซ้อน